Phase 1 Project Report
National Park Service Coastal Visitor Impact Monitoring

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EXECUTIVE SUMMARY

This report details the findings of the initial, observational phase of a research project examining the development of appropriate indicators of visitor impacts to natural resources in eastern coastal and barrier island areas managed by the National Park Service. Preliminary observations and manager interviews suggest that visitor impacts are a concern at most of the seven NPS areas examined, but the extent and type of concern is somewhat area-specific. Within zones of high resource protection and across all of the areas examined, visitor impact concerns fall into two major categories, 1) trampling impacts to vegetation and soils and 2) visitor impacts to wildlife and wildlife habitat. A literature review on coastal visitor impacts, area-specific reports and preliminary selection of monitoring indicators are provided.

SECTION I- Overall Project Report

Project Background

A research project, "National Park Service Coastal Visitor Impact Monitoring" was initiated formally in September 2002. As proposed, this is a two-phase study to test candidate variables for future visitor impact monitoring programs at seven important coastal areas managed by the National Park Service (NPS). These areas are as follows:

Assateague Island National Seashore, Maryland
Thomas Stone National Park, Maryland
Fire Island National Seashore, New York
Gateway National Recreation Area, New York
Sagamore Hill National Historic Site, New York
George Washington Birthplace National Monument, Virginia
Colonial National Historic Park, Virginia

Specifically, this "Phase 1 Project Report" summarizes the salient findings from the preliminary aspects of the project. These include a scientific literature review of coastal visitor impacts, reports from extensive site visits and manager interviews, a rational for selecting candidate indicators of visitor impacts and a preliminary selection of candidate variables for field testing during 2003.

Project Context and Conceptual Framework

Considerable research has been conducted over the last 35 years on the consequences of recreational activities on natural resource conditions (Leung and Marion, 2000). This project seeks to build on this knowledge and on the recent monitoring efforts at Cape Cod National Seashore (Marion and Cahill 2003) and Boston Harbor Islands (Leung, 2002) to design and test an effective visitor monitoring project that will:

1) Determine which of the NPS units as listed above are in need of visitor monitoring and visitor impact monitoring programs
2) Identify ecosystems of critical concern where visitor impacts to resources are problematic and future management of these areas can lead to increased resource protection
3) Develop and test appropriate and accurate monitoring and sampling protocols to document the attributes of visitation for recreation activities of resource impact concern occurring at selected NPS areas
4) Develop and test appropriate and accurate monitoring and sampling protocols to document the nature and severity of recreation impacts to vegetation, soil, and wildlife at selected NPS areas

Considerable literature exists on the management of visitor impacts to resources (e.g., Hammitt and Cole 1998; Manning 1999). The development of specific, accurate monitoring indicators is considered fundamental in the management process and moreover is an essential process in various management frameworks (Manning 1999).

This project is part of the NPS Vital Sign Program that was created for monitoring conditions of important natural resource variables indicative of ecosystem health and resource integrity. This specific project addresses visitor use in national parks as a threat to natural resources. Visitors to coastal parks are engaged in a wide array of recreation activities, most of which generate some level of impact. Due to the scope and issues in coastal visitor impacts, it is necessary to define the focus of this project clearly.

While visitor activity impacts may occur in many areas, impacts occurring within sensitive, natural/pristine or protected zones are of most concern because of the ecological and social value of these areas. Monitoring visitor impacts in these areas are consistent to the objectives of Vital Sign Program and would provide most valuable input to the Program as the impacts may constitute a significant threat to ecological health.

In contrast, visitor activity impacts in developed or high-use areas are expected and can be controlled through intensive facility development and site hardening. In this case monitoring visitor impacts is less beneficial to the parks involved. We also restrict our focus to impacts that occur in terrestrial zone, within which indicators can be more effectively defined and measured. Some visitor-caused impacts, such as water pollution and human waste were not included.

In light of this literature and in the context of this project we propose the following criteria for the further development of specific indicators of visitor impacts to resources and in the testing of these candidate variables:

1) Focus exclusively on areas of the highest level of resource protection as determined by the current GMP and advice from land managers. For example, designated wilderness and natural/wildlife zones. Areas where motorized use, visitor facilities, residences and other developed-area activities take place will only be considered indirectly, i.e., where spill over effects are occurring in designated areas of high resource protection.
2) In the areas of high resource protection, monitoring efforts will focus on the elements of dispersed recreation activities that have the potential to adversely affect soil, vegetation, and wildlife resources.
3) In frontcountry and developed areas, facility and site solutions are widely accepted and the most effective. While monitoring for visitor experience conditions may be applicable in these areas, there is little need to quantify natural resource impacts from a park management and preservation standpoint

4) While visitor impacts to water and air resources can be significant in some cases, these issues are best considered under the context of air and water quality monitoring programs where these specific expertise are available.

The above approach parallels the efforts at Cape Cod National Seashore (Marion and Cahill, 2003) and is supported by the findings of the Visitor Use Management Working Group of the Coastal Monitoring Network (Marion, et al., 2001)

Summary of Literature Review

One of the tasks set forth in the Phase I project was to conduct a comprehensive review of scientific literature on visitor impact monitoring programs and techniques as applied in coastal areas comparable to the study park units. Such review will inform us with the state-of-the-art of monitoring techniques, facilitating our development of monitoring protocols for the seven national park units.

A concise summary is provided in this section. In addition, two products will be developed through the literature review process. A poster is being developed and will be presented at the George Wright Society Conference in San Diego, CA in April 2003. The poster intends to provide an understanding of coastal visitor impact monitoring methods to conference attendants and to solicit input from park scientists and managers who may have knowledge of monitoring programs or techniques that we might have overlooked or do not have access. The second product of the literature review is a manuscript to be distributed to seven national park units. This manuscript aims to inform scientists and managers in the participating national park units about current development in visitor impact monitoring techniques. Journal publication of this manuscript will be sought.

Due to the nature of the project we limited the scope of our literature review to coastal areas with sandy shores and barrier islands. We identified relevant publications in our personal databases and also conducted thorough searches in reference databases through the university libraries. A substantial number of references were identified, but only a small portion of these references is applicable to sandy coasts and barrier islands. Several studies were actually conducted in the park units included in this project (such as Patterson et al., 1991; Steiner and Leatherman, 1981).

Research on Coastal Visitor Impacts

Earlier studies of visitor impacts to coastal areas have been reviewed (Leatherman 1988; Vaske et al., 1992). Leatherman and Steiner (1987) compiled an annotated bibliography with 110 entries on the impacts of off-road vehicles and walking traffic on coastal ecosystems. This bibliography included both social and environmental impacts, and most of the entries are rather dated (1970s or earlier).

Off-road vehicle (ORV) use was an early but consistent visitor impact concern in coastal parks, particularly on barrier islands and near sand dunes (Rickard et al., 1994). At Cape

Cod National Seashore, Godfrey and Godfrey (1980) conducted a comprehensive study on the effects of ORV use on different ecological components such as birds, sand dunes and salt marshes. Management implications of their findings were provided (Godfrey and others, 1980). In the same region, Carlson and Godfrey (1989) applied vegetation survey and mapping techniques to evaluate the effectiveness a visitor management plan developed for R.T. Crane Jr. Memorial Reservation in Massachusetts. McAtee and Drawe (1981) studied recreational impacts to the beach and foredune microclimate in Texas. The primary effect was reduced vegetation cover and lower species diversity. They also found that as recreational activities increased, the dune height decreased. In North Carolina, Hosier and Eaton (1980) studied ORV impacts to dunes and found that vegetation cover and the number of species to be lower in areas with ORV use. The potential impacts of ORVs to macroinvertebrates.have also been investigated (Wolcott and Wolcott, 2003).

Much of the literature focused on the effects of visitor impacts to the ecological communities. Steiner and Leatherman (1981) studied the distribution of ghost crabs at Assateague Island National Seashore in relation to ORV and pedestrian usage. Pedestrians were found to have no harmful effects on ghost crabs. In fact, the density was higher in these areas, possibly due to the abundance of food scraps. The ORV sites contained significantly fewer ghost crabs than the pedestrian sites. The difference between areas of high and low ORV use was not significant. Barros (2001) found the number of ghost crab burrows in non-urban beaches to be higher than in urban beaches.

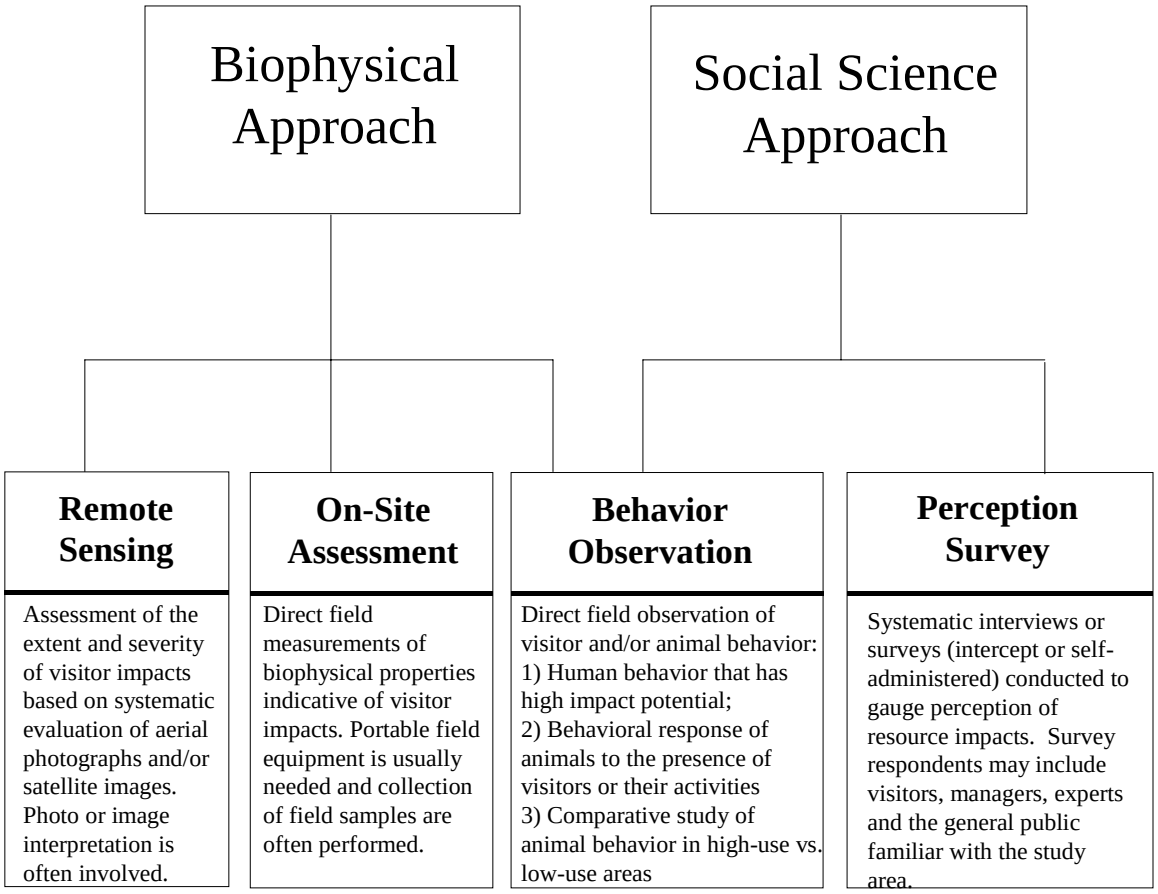
Thomas, Kvitek, and Bretz (2003) studied the effects of visitor activities on the foraging behavior of sanderlings. They found through field observation that the number and proximity of people, their activity, and the presence of free running dogs significantly reduced the amount of time sanderlings spent foraging. Through a controlled experiment, they found group size to be significant in reducing foraging time. In both measurements, they found that sanderlings respond (by either running or flying) to humans within 30 meters. Burger (1986) found that only 30% of birds were unaffected by human activity, most birds flew away in response. Burger was unable to determine if these activities were harmful to the overall health of the birds, but indicated that disturbance during prime foraging times would have an adverse affect on health. Patterson et al. (1991) found no evidence to suggest recreational activities had a detrimental affect to the productivity of piping plovers. Low productivity was attributed to predation.

Visitor Impact Monitoring: Methodologies and Techniques

A thorough review of relevant scientific literature suggests that there are two dominant methodological approaches to visitor impact monitoring in coastal areas (Figure 1). The *biophysical* approach includes studies that evaluate the extent and intensity of visitor impacts based on remotely sensed data or direct measurements of recreation sites, coastal habitats and wildlife behavior. Within this first approach remote sensing, on-site assessments and observation of animal behavior are the three major groups of techniques. On the other hand, studies that employ the *social science* approach evaluate the extent

and intensity of visitor impacts based on (a) perception of park visitors, managers, local experts and/or general public or (b) direct observation of visitor behavior that has high impact potential. The following is a concise description of each group of techniques with examples from past studies.

Figure 1. A classification of visitor impact monitoring techniques developed for coastal parks and protected areas.



1. Remote Sensing

Remote sensing refers to the detection and recording of values of emitted or reflected electromagnetic radiation with sensors onboard aircraft or satellites. This group of techniques is particularly useful for monitoring easily detectable visitor impacts that occur in a large expanse of coastal areas. Butler and Wright (1983) discuss the potential of remote sensing in recreation research including the measurement of user density and intensity and comparison of changes over time. Welch, Madden, and Doren (1999) created databases of digital maps detailing vegetation and ORV trails in the Everglades for use in management and modeling. Hockings and Twyford (1997) used aerial photography to identify beach camping impacts. They used the extent of clearing and vehicle tracks as indicators. They compared their findings to ground surveys and found

aerial photography to be a valid and reliable measure. Aerial photography was also used in the study to exam spatial and temporal changes within the campsites.

2. On-Site Assessment

On-site biophysical assessment refers to direct measurements or assessments on the ground, usually with portable field equipment. This research approach may also involve collection of field samples for laboratory analysis. A number of campsite impact studies were recently conducted in North America (Gajda et al., 2000; Monz, 1998). These studies extended field procedures from earlier studies conducted in inland forests and parks (Leung and Marion, 2000). In North Carolina, Buerger and others (2000) assessed impacts of recreation to a barrier island. Researchers identified impact areas as sites (resulting from camping, picnicking and boat landings) and trails. Physical impacts such as compacted sand, loss of vegetation, and trash were recorded. These impacts were compared over time to determine if mitigation of recreation impacts occurred naturally. They found the degree mitigation depended largely on the location of the impact on the island. Sites closer to the water had a higher level of mitigation. Chandrasekara and Frid (1996) used onsite measurements to determine the effects of trampling on tidal flat infauna. Faunal and sediment samples were taken from the site and brought to the lab for further analysis. Sediment pH was measured on site. They found trampling caused a change in the composition of benthic fauna.

3. Behavior Observation

Behavior observation is a group of techniques that may fall within either biophysical or social science methodological approach, depending on the actual subject of observation. In visitor observation, human behaviors that cause impacts are systematically observed. On the other hand, immediate behavioral response of wildlife to the presence of visitors or visitor activities is observed in wildlife observation. These techniques can be used together (Burger, 1986; Thomas et al., 2003) or separately (Patterson, Fraser, and Roggenbuck, 1991; Loegering and Fraser, 1995). Burger (1986) found walking (40%) and fisherman (10-20%) to be responsible for the majority of disturbances to shore birds. Dogs accounted for less than 10% of the disturbances. Shorebird responses were recorded as one of three behaviors, remained at the site, flew away but returned, and flew away and did not return. While there were some differences between sites, the percentage of birds that flew away and did not return was inversely related to the number of disturbances. Burger also found evidence to suggest that birds in small flocks were more likely to fly away and not return than birds in large flocks. Thomas, et. al. (2003) found that group size, activity type and free running dogs tend to have a significant effect on the foraging time of sanderlings. Observation of behavior has also been used to determine if human disturbance had an effect on animal survival (Patterson et al., 1991; Loegering and Fraser, 1995).

4. Perception Survey

The extent and severity of visitor impacts may be evaluated based on human perceptions of such problems. This social science approach can be implemented in forms of systematic interviews and/or surveys (intercept or self-administered). Survey respondents typically include visitors and managers of the study area. However, the

general public and professionals who are familiar with the study area may also be surveyed. Vaske, Deblinger, and Donnelly (1992) used written self-administered surveys to understand visitor perceptions of conflict and of the natural environment. Responses were separated by user group (pedestrian, boater, ORV user) and by use area. They found that boaters were less educated about the ecology of the area, regulations, and human impacts. Survey responses also revealed that visitors felt the beach area was becoming crowded. The responses from the surveys were combined with ecological data to create new management techniques. Becker and others (1986) assessed the threats of human impacts to coastal areas based on a survey of visitors and public, though managers and experts were also involved. Similar to the survey of visitors and public, survey or interview of managers may also be used to gauge the extent and intensity of visitor impacts based on managers' or experts' perception. In Becker and others' (1986) study coastal park manager and experts were also involved in the survey. No other park manager/expert surveys focusing on perceived visitor impacts in coastal areas have been identified.

Summary of Managers Interviews and Site Visits

Visitor impacts to coastal resources are a significant concern to managers in all areas visited, although the degree of concern and the potential for significant impact is highly area dependent. For example, Gateway National Recreation Area, located within the limits of New York City, sees over 8 million visits per year, with many of these visitors engaged in activities that can potentially affect coastal resources. Conversely, at Sagamore Hill National Historic Site the majority of visits occur in the museum facilities, with very little current activity on the trails and the small barrier island area. Given these differences in visitor activities, the nature and extent of monitoring activities will be highly area specific, but all areas could benefit from some level of visitor impact monitoring. For site-specific monitoring recommendations, please refer to the area findings contained in this report.

For the purpose of this study, we have identified two categories of visitor impact concerns 1) those applicable to the development of monitoring indicators in the context of this study (*Study Impact Concerns*) and 2) those beyond the scope of this study but raised by managers (*Additional Impact Concerns*)

Several *study impact concerns* are common to many of the natural areas in the Coastal Network, specifically:

1) Trampling impacts to vegetation and soils. All areas reported and we observed both current and potential impacts to beach and upland vegetation communities as a consequence of day and overnight use. Trampling is primarily caused by foot traffic, and in Colonial NHP, by mountain biking use (see Section II). Managers report that little if any information exists on the location and extent of these impacts and whether impacts are changing over time. In some cases these impacts are site specific, in areas where use is concentrated (i.e., campsites, coastal access

points for fishing) and off hardened or resistant substrates (i.e., boardwalks and sand, respectively). In other cases these concerns are more widespread, such as the impacts of beach visitors to coastal sea beach amaranth, a federally listed plant species.

2) Wildlife Impacts. Although managers raised some area specific wildlife impact issues, two overall concerns were raised by managers at several areas:

    a. The impact of visitors on piping plover (*Charandrius melodus*) habitat. Piping plovers occupy sand beaches and tidal flats and their numbers have been declining in recent years due to the extensive beach disturbance. Although significant management efforts are in place to limit visitor disturbance and preserve habitat during nesting season, it is not clear in all cases as to the level of visitor compliance with exclosures and interpretive information.
    b. Illegal harvesting and interaction with wildlife. Assateague and Gateway have concerns about the harvesting of fish, crabs, clams, and horseshoe crabs. Gateway experiences the illegal poaching of these animals and managers do not know the extent of impact caused or exactly how to prevent such activities. Managers at Assateague are concerned with the feeding and contact that visitors have with the wild horses.

One *additional impact concern* is of note at several areas is as follows:

3) Off Road Vehicle (ORV) Use. Managers at Assateague, Gateway and Fire Island have raised concerns about the impacts of ORVs to coastal dune flora and fauna. At each of these areas, ORVs are limited to designated zones, specific trails and/or travel corridors. In most cases total numbers of ORVs are limited by permit systems. Manager's observations would suggest that the nature and extent of ORV use has changed substantially at these areas over the last 10-20 years with increases in numbers of visitors and shifts in visitor activity preferences. At Assateague, for example, previous ORV use was limited to a large extent to visitors engaged in sport fishing activities. As such, visitors would drive to an area above the tide line and park. Recently with the popularity of sport utility vehicles, more visitors are coming just to drive the beach, picnic, have campfires, swim or to day hike into the nearby dune and forest communities. Given the scope and extent of this project, we will not be developing monitoring indicators to address specific issues within the designated ORV zones, trails or corridors. Monitoring protocols will address any impacts in natural areas adjacent to ORV zone where visitors may be traveling on foot or (illegally) by vehicle.

Conclusions for Phase 1 and Proposed Phase 2 Approaches

Proposed Vital Signs and Candidate Variables - Phase 2

Vital signs are key elements, process or features of the environment that can me measured and that indicate the condition of an ecosystem (Marion and Cahill 2003). Phase 2 of this project will seek to address the study impact concerns as highlighted by managers and as outlined in the overall project plan by developing specific monitoring protocols for the specific measurement indicators identified.

Vital signs, approaches and measurement indicators appropriate to address these concerns fall into three categories; visitor use (Table 1), vegetation and soil degradation (Table 2) and disturbance of wildlife (Table 3). Phase 2 will consist of extensive field testing of assessment methodologies according to the vital signs specified below (Tables 1-3). A Phase 2 work plan (in preparation) will detail the specific tasks and timetables to be accomplished at each site following the initial suggestions of the study impact concerns detailed in each site visit report (Section II).

Table 1. Vital Signs, Approaches and Indicators for changes in visitor use in natural zones

Vital Sign	Approach	Measurement Indicators
Types of Recreation Use	Managers Survey Direct Field Observation Entry Point Visitor Survey	Use Type
Amount of Recreation Use	Managers Survey Direct Observation Trail/Vehicle Counters	Scale Ratings of use Frequency Observed number of visitors by activity type Number of hikers along selected trail segments
Distribution of Recreation Use	Managers Survey Direct Observation Trail/Vehicle Counters	Location and extent of recreational use

Table 2. Vital signs, approaches and indicators for extent of vegetation and soil degradation in natural zones

Vital Sign	Approach	Measurement Indicators
Vegetation Loss	Direct On-site Measurement at recreation sites and along trails	Relative cover loss (%) Changes in Bare ground (%)
Vegetation Compositional Change	Direct On-site Measurement at recreation sites and along trails	Individual Species Cover (%) Presence/Absence of invasive plant species
Unintended Trail Formation	Direct On-site Assessment and Mapping	Location, extent and mapping of visitor-created trails
Unintended Site Formation	Direct On-site Assessment and Mapping	Location, extent and mapping of visitor-created sites
Shoreline Disturbance	Direct On-site Assessment and Mapping in sensitive areas	Location, extent and mapping of shoreline disturbance sites
Disruption of Submerged Aquatic Vegetation	Direct On-site Assessment	Location and Extent of disturbance

Table 3. Vital signs, approaches and indicators for disturbance of wildlife natural zones

Vital Sign	Approach	Measurement Indicators
Disturbance type	Direct Behavior Observation	Type of visitor activities affecting wildlife (i.e., shorebirds)
Disturbance time	Direct Behavior Observation	Length of time of disturbance events
Attraction Behavior	Direct Behavior Observation	Number of occurrences of wildlife feeding Number of occurrences of attraction behavior

SECTION II- Site Visit Reports

Assateague Island National Seashore

Initial Site Visit
September 12, 2002

Project Staff: Christopher Monz, Yu-Fai Leung, Christine Ingle, and Heather Bauman

Park Staff Present: Carl Zimmerman, John Burns, Chris Finlay, Jack Kumer, and Mike Hill

Background

Assateague National Park is located on the northern Maryland half of a barrier island off the coast of Maryland and Virginia. The Island is 37 miles long encompassing Assateague National Seashore, Assateague State Park, and Chincoteague National Wildlife Refuge.

The National Seashore has many prominent habitats: beach habitat generally made up of dunes, beach grasses, the endangered beach amaranth, and many other types of native vegetation, as well as offering habitat for many shorebirds including the Piping Plover, Oyster Catchers, and Terns. Assateague has some unique estuarine habitats, which are some of the highest quality estuarine habitats on the eastern seaboard, marshes, and forests, which primarily consist of wax myrtles, bayberry, loblolly pines, and willows.

Assateague National Park has completed a management plan and continues to desire improved management strategies to protect the barrier island's sensitive ecosystems while maintaining a high level of visitor satisfaction.

Within Assateague's management plan there is reference to designate the backcountry as wilderness. Although it has been rejected by the park service when the management plan was written they plan to revisit the subject this year when the area being considered is free of retained rights.

Ninety to ninety five percent of visitors that come to Assateague stay within the four and a half miles of developed area. The developed area includes access to the ocean and beach, clamming on the bay side, Old Ferry Landing where visitors put in canoes and kayaks, and two nature trail access points.

Two studies have been conducted on the consequences of recreation activities on wildlife at Assateague. One study on Piping Plovers suggests that the Plover fledging rates are lower than necessary to maintain a viable population (Patterson, et al., DATE). The study concludes that human recreational participants have very little to do with Plover productivity and that predators accounted for 91 percent of nest losses.

The research on the Ghost Crab *Ocypode quadrata* found less crabs per HA on ORV zones than on undisturbed, or pedestrian-impacted areas of beach (Steiner and Leatherman, 1981). The crabs seemed to be most abundant where there was pedestrian traffic. The paper reports that ORVs could be potentially hazardous to the crabs by crushing them, burying them, altering their environment and possibly indirectly interfering with their reproductive cycle.

Visitor Natural Resource Impact Issues and Concerns

Off Road Vehicle(ORV) Use

The majority of visitors that come to Assateague come to drive their Off Road Vehicles (ORV) onto the beach in order to access the beach areas from the South Ocean Beach entrance to the state line. ORV use is limited to a zone marked by PVC poles presenting boundaries that keep vehicles away from sand dunes. The vehicles are allowed to drive from this boundary to the edge of the ocean surf. As many as 145 vehicles are allowed on the12 linear miles of beach. This stretch of the beach is often at full capacity daily from July through August, with visitation decreasing after labor day. ORV use on Assateague has doubled in the past decade and managers are concerned over the impacts the vehicles are having on the beach ecosystem.

Observations from park staff and from our own park visit suggest that vehicles cluster on the first five or so linear miles of the ORV zone. Shorebirds such as oystercatchers, terns, and others were viewed in the spaces between the grouped vehicles while almost none are seen around the vehicle clusters.

The managers know the amount of vehicles that drive onto the beach daily, however, no studies have been done on the spatial distribution of vehicles or how many vehicles cross the ORV boundary zone and drive illegally to campsites or on old backcountry roads.

Visitors are not allowed to camp in their ORV overnight, however, there is an unadvertised space behind some dunes where vehicles are allowed to “park” overnight.

Horses and Human Interactions

Horses might be the second most popular reason that visitors come to Assateague. The horses on Assateague are descended from domesticated stock brought to the island around the 17th century by Eastern Shore planters trying to escape mainland taxes and fencing requirements. Today these horses are managed by the National Park Service (NPS) as a wild native species.

Many problems are associated with the horses at Assateague. Many people, although warned by signs, brochures and park staff, approach the animals and get bit or kicked almost on a weekly basis. The horses also feed on native vegetation such as dune grass that stabilizes the sand and the endangered sea beach amaranth. The horses cause damage to fences, tents, and other equipment or structures. Park managers also invest a great deal of money and time shoveling horse manure off of trails, roads, and out of campsites.

The horses at Assateague provide visitors with the chance to see what are now defined as "wild horses". They are important from an historical aspect, so it remains unlikely that the horses will be removed from Assateague. Managers are trying to limit the horse population, which is now about 176 animals by darting the mares with a pregnancy inhibitor. They have also been discussing the possibility of fencing off the developed area so that the majority of the public will not come into close contact with these feral-wild horses.

Camping and Campgrounds
There are two campgrounds at the northern end of Assateague and six backcountry campsites and a few ocean side walk-in sites. The main campgrounds are provided with chemical toilets, drinking water, and cold, rinse-off showers. The backcountry campsites are equipped with portable toilets, a fire ring, a picnic bench, and a pole for hanging food. The ocean side walk-in sites are provisioned with portable toilets and a fire ring. Visitors must bring their own wood to burn in fire rings at campsites or openly on the beach. This has raised concerns about the chemicals in pressure treated wood and other wood sources that possibly release toxins into the soil.

Backcountry campsites are defined by natural boundaries and have not been rated in terms of impact. Since there is no drinking water provided in the backcountry, there is some concern about where people go to wash dishes and what type of soap they are using. Park rangers are questioning whether they should provide a facet and drainage to collect gray water and dispense of it elsewhere or if it would become too much work for the park staff to maintain.

Motorboats and Personal Watercraft Use
Motorboats that access Chincoteague Bay from the mainland are allowed in Assateague waters, as well as to beach anywhere along the bay side. Most of the islands bay side is too shallow to allow motor boats, except perhaps the northern end where it is hard to monitor visitors that come in by boat.

Personal watercraft use is prohibited in Assateague waters at this time although illegal use occurs both on the ocean and bay side. The park is currently involved in a rulemaking process that will potentially open up two sites for personal watercraft use, at the very northern tip of Assateague, and south in Chincoteague near Tom's Cove. Park rangers do not have any baseline data about how many water vehicles they should allow in an area or how to monitor visitors that come to the island by water.

Canoeing and Kayaking
Canoeing and kayaking is open to visitors from one docking point on the bay side of Assateague Island. Because canoes and kayaks can navigate in shallow waters it would be easy for people to land almost anywhere on the island and create associated resource impacts. Opportunities for canoe and kayak camping exist on the western side of the island as the backcountry campsites are easily accessed by these means. Currently the level of canoe and kayak use is unclear.

Fin Fishing, Clamming, and Crabbing
The National Park does not require permits for fin fishing, crabbing, or claming. It is assumed that visitors fish, crab, and clam recreationally, however, since it is not highly regulated some commercial use may exist. Some associated impacts to soil and vegetation and other wildlife species have been observed with these activities. For example, many people have also reported trapping turtles instead of crabs in their baskets.

The Landing Area
The Landing Area where recreational crabbing and claming takes place as well as the put in spot for canoes and kayaks is an area of concern. This area has a boardwalk that travels from the island to a smaller island offshore and then ends. At the end of this board walk there is a network of social trails that spider throughout this small island, leading around the island, and across to most of its shores. Soil compaction, vegetation loss, and bird disturbances are all of concern in this area.

Hunting
Hunting is another activity that visitors enjoy at Assateague. The park provides 25 sites with 22 blinds for waterfowl hunting. In the future managers want to replace the high maintenance blinds with designated hunting areas. These hunting areas will be marked with a stake requiring hunters to stay within a 100-meter radius. It is likely that more social trails will be created as blinds are taken out and hunters are given areas in which to move around.

Roads and Asphalt Runoff
One Park Ranger voiced concern over roads and particularly an old road that runs the length of the island but has since been abandoned. This road constructed in? was created by scooping sand up and pouring oil onto it. The road is now broken up into pieces with some parts under sand and vegetation.

Initial Monitoring Recommendations

Study Impact Concerns
Given that the visitor impacts, potential impacts, and issues are both vast and complex many management decisions need to be made. This project strives to assist the managers in their decision making process by developing and testing candidate indicators and monitoring protocols on particular management issues. Therefore we suggest the following assessment and monitoring techniques for the summer- fall 2003 field season.

1) We recommend that indicators and monitoring protocols be developed and tested for soil and vegetation impacts on backcountry campsites and hunting areas. Measuring the size and rating the conditions of campsites and hunting areas and blinds can provide baseline data of resource conditions in these areas. Further

mapping of all the social trails in and around campsites, blinds, and hunting areas will also be necessary to monitor any changes in impact that occur.

2) The Landing Area where visitors put in their kayaks and canoes as well as crab and clam is another area that needs assessment. Many social trails are visible in this area and will need to be mapped to monitor any changes and the rate of changes that occur in the future.

Additional Impact Concerns

3) The ORV use in the Seashore is extensive and is potentially the single largest visitor impact concern. Although total numbers of ORV visitors are known, little is known about the spatial distribution of use and visitor behavior in the ORV zone We suggest that ORV use be monitored in this study by a visitor survey, direct observation and by fitting GPS units to vehicles on a voluntary basis. In this way we can assess the extent, location and frequency of ORV use in the designated zone. Once the ORV movements are mapped, assessments can be made as to whether or not the ORVs are a great danger to beach habitat. Mapping changes in the future will help managers find any changes in use and distribution.

4) Park managers raised several issues regarding runoff from asphalt surfaces. Although this is not necessarily something we can assess directly with this project, we may be able to review the literature and determine if this is a concern for future research.

Sagamore Hill National Historic Site

Initial Site Visit
June 11, 2002

Project Staff: Christopher Monz

Park Staff Present: Scott Gurney

Background

Sagamore Hill National Historic site is located in the town of Oyster Bay, NY, on the north shore of Long Island. The main visitor attraction at the park is the Theodore Roosevelt Home and guided tours are provided. There is no overnight use.

The Park is a total of 87 acres and contains a several ecosystems of note: a dense forest of generally native trees (tulip trees), restored meadows and pastures with a mix of native and one native vegetation, an intertidal marsh and a barrier island ecosystem. The forest ecosystem is one of the few, and possibly the only significant parcel of native forest remaining in all of Nassau County. The marsh and barrier island ecosystem, although small (9 acres, are also significant as undeveloped land in an area where significant coastal development has occurred. The shoreline up to mean high tide is managed by the USFWS as a wildlife sanctuary.

Sagamore Hill currently has no finalized general management plan. The park strives to strike a difficult balance between several factors; maintaining the cultural resources of the house and adjacent buildings, restoring areas to resemble the original condition and uses at the time of the Roosevelts, maintaining natural conditions and preserving wildlife habitat.

Several biological inventories have been initiated (such as a plant collection) but is not clear as to the current status of these efforts.

Adjacent land owners seem to often times complicate management in the park. The parks neighbors are extremely wealthy and the estates nearby do not necessarily share the same objectives for their lands bordering the park. Sometimes neighbors object to particular management actions the park is taking. Park visitors have also expressed concerns when a part of the park is not managed in a way that resembles the way they remember it being when they first visited. For example the park has received some negative feedback on their efforts to restore native vegetation to several areas, despite it even being more appropriate from a historical aspect, i.e., more closely resembling what was present at the time of the Roosevelts.

Visitor Natural Resource Impact Issues and Concerns

The vast majority of visitor to the park come with the intention of viewing the house and museum exhibits. In this capacity most visitors are guided by interpretive rangers and

park curators. Other, significant visitor opportunities do exist, however. Formally the park staff led interpretive walks in the forest and down to the waterfront. These areas are currently closed, but there is discussion of developing a program of managing visitors on trails and developing some new trails.

Currently existing trails, although not extensive (perhaps 2 miles total lineal distance) are well developed and designed with no obvious design and maintenance issues. One exception might be the wooden boardwalk/bridge leading to the barrier island, which is possibly nearing the end of its design life.

Some illegal use does exist with boats landing on the barrier island beach. It is not clear how much use of this kind is occurring at present, but it could represent a significant disturbance to these sensitive ecosystems.

Initial Monitoring Recommendations

Study Impact Concerns

Given the current lack of substantive visitor use in sensitive areas, visitor impact monitoring may not need to be extensive at this time. However some initial information at this time would be beneficial in assisting the park in establishing a baseline of resource condition. For example, trail and barrier island photo monitoring and GPS mapping of the trail locations would be helpful. Therefore the following assessment steps are suggested for the 2003 field season:

1) GPS mapping of all trail locations
2) The development of a series of permanent monitoring photo points along the trails and on the barrier island.
3) Assessment of the location and extent of any trail design/safety concerns for possible future maintenance.

A GIS database would be developed with the above information and provided to the NPS at the end of the project in addition to a written report with monitoring protocols and future monitoring suggestions.

George Washington's Birthplace National Monument (GEWA)

Initial Site Visit
October 4, 2002

Project Staff: Yu-Fai Leung, Christine Ingle

Park Staff Present: Rijk Morawe (natural resource specialist), Vidal Martinez (superintendent), John Frye (Interpretation supervisor), Ben Hansel (law enforcement officer)

Background

George Washington's Birthplace National Monument (GEWA) is located east of Colonial Beach (Westmoreland County, Virginia) within the Chesapeake Bay watershed. It was established as a National Monument on January 23, 1930 and officially opened to the public in 1932. GEWA has a total acreage of 550 acres and comprises two portions that are separated by a private property. The main section of the park consists of the Historic Area (including the George Washington's birthplace site), the Burial Grounds, Popes Creek picnic area and the Potomac River beach. The northeast section consists of pine stands and marshy areas at the mouth of Popes Creek.

The original home where George Washington was born burned down in 1779. In 1936 the house was excavated and its foundations preserved. The park also contains the Washington family gravesite and the Memorial Shaft, which is a 1/10th replica of the Washington Monument in Washington, DC. The Historical Area of the park simulates 18th century Virginia. This area includes a kitchen house, colonial herb and flower garden, and the Memorial House. The Memorial House is a recreation of a typical upper class manor house of the time. Costumed interpreters are available throughout the Historical Area demonstrating different jobs and crafts of the time period. However, the park's interpretation is emphasizing more on George Washington and his family.

In addition to rich cultural heritage, GEWA also possesses a variety of natural resources. They include stretches of sandy beach along the southern shore of Potomac River, saltwater and freshwater marshes, and upland forest comprising primarily pine stands. Park staff indicated that the coastline along Potomac River has been receding during the past few years.

In 2001, the park received 150,672 recreational visits with visitation highest in the summer. The amount of visitor use peaked in 1976 and has dropped since then. An entry fee of $3 is charged for visitors over 16. In addition to observing the historic sites, visitors are also allowed to bike, fish, crab (at the designated fishing area), bird watch, hike, view wildlife, take nature walks, picnic and auto tour. The Popes Creek Nature Trail is used by most school groups. Park staff estimated that about 30% of visitors walk on this trail.

As specified in GEWA Code of Federal Regulations Compendium, most non-traditional uses are prohibited. Examples include swimming, overnight camping, boat-launching, organized group sport activities, kite flying, ball playing, and use of any amplification devices. Fishing is permitted only at the Popes Creek Designated Fishing Site next to the picnic area and the Potomac River Beach. Pets must be on leash, and they are prohibited on nature trail, historic area, visitor center complex, burial grounds, and all buildings.

A general management plan is being developed and will be completed in 2004. The park's budget was $1,096,000 in 2001.

Through literature searches and discussion with park managers no studies were identified that investigated visitor impacts on natural or cultural resources. There is no ongoing program developed for monitoring visitor impacts.

Visitor Natural Resource Impact Issues and Concerns

Resource Degradation Associated with Fishing
Park staff indicated that resource degradation caused by fishermen is their *primary* visitor impact concern. A variety of impacts at both designated fishing areas are attributed to fishing activities and the depreciative behavior of some fishermen. Examples of impacts include inappropriate disposal of garbage (such as beverage containers, fishing lines, toilet paper), creation and use of social trails, and trampling impacts on groundcover vegetation and soil.

Illegal Collection of Fossils
Another significant concern of park staff is beach combing activities and related illegal collection of fossils such as shark's teeth. Fossil hunting was once encouraged in the past but has been defined as an illegal act since late 1980s. However, there is still a small portion of visitors who come to the park solely for beach combing purposes. They usually stay on the beach for several hours. The amount of fossils that have been lost due to illegal collection is unknown. The extent and significance of this problem is complicated by the beach's dynamic environment.

Parking around the Memorial Shaft
A park staff voiced concern about visitors who park along the roadside around the rotary near the park entrance. Most visitors park their cars there only momentarily for the purpose of taking photographs of the memorial shaft. Some groundcover vegetation has lost as a result. During our visit we did not observe substantial damage in this area.

Illegal Recreational Activities
While prohibited recreational use is clearly defined and conveyed to the public through signage and personal communicated, illegal recreational use occurs from time to time in the park. The frequency of each type of violation is unknown. Examples that have been observed by park staff include launching of canoes and kayaks, setting up tents on beach, and swimming.

Cultural Resource Impact Issues and Concerns
While beyond the scope of this specific project, visitor impacts to cultural resources and historic structures are of major concern to park managers. These impacts take a variety of form, including littering on the historic area and the burial grounds, and possible vandalism on the graves of George Washington's family.

Other Impact Issues
Park managers also expressed concern about the pressure for residential development in the nearby areas across from Popes Creek as the development would potentially compromise the view sheds of the park. Establishment of communication towers in view from the park adds to such concern. In addition, noise created by personal watercraft use outside the park boundary has at times interfered with the historic interpretation activities in the park.

Initial Monitoring Recommendations

Based on our discussion with park staff and our observation, we propose the following monitoring effort for GEWA:

Study Impact Concerns

Fishing use and impacts of the park is the primary concern among park staff. While fishing use patterns are basically determined by the designated site policy, little is known about behavior patterns of fishermen. In addition, there is no information exists that quantify the extent, patterns and trends of resource impacts related to fishing despite the significant concern. We suggest that candidate indicators and associated monitoring protocols be developed and tested for fishing-related impacts in this park. Monitoring protocols should document the forms, extent, intensity and distribution of impacts. Field survey techniques would be developed and implemented with involvement of park staff. To better understand fishermen and their behavior a fishermen survey might be considered pending on funding and availability of assistance from park staff.

Additional Impact Concerns

1) While there are technical difficulties involved, monitoring techniques may be developed to evaluate the extent and patterns of illegal collection of fossils. However, additional funding or resources may be needed in order to successfully develop and implement this particular type of monitoring. For example, real or imitated shark's teeth or artifacts can be placed systematically along a defined segment of beach above the high tide and the rate of their appearance can be inferred to as rate of loss due to illegal collection. An alternative way to monitor this problem could be through behavior observation, though uncertainties exist as to what type of material is picked up by visitors without really confronting them.

2) Visitor damage to cultural resources may be monitored through some rapid procedures that can be performed by park staff during regular patrols. This issue appears to be beyond the scope this project under the Vital Signs Program. However, we may be able to help in developing monitoring procedures based on the literature.

3) Illegal recreational use of the park can be evaluated through a compilation and analysis of citations and observation of park staff. This problem occurs so infrequently that it might not be on the top of the priority list of developing monitoring programs.

Thomas Stone National Historic Site (THST)

Initial Site Visit
October 4, 2002

Project Staff: Yu-Fai Leung, Christine Ingle

Park Staff Present: Rijk Morawe (natural resource specialist), Vidal Martinez (superintendent), John Frye (Interpretation supervisor), Ben Hansel (law enforcement officer), Andrew Packett (acting supervisory park ranger), Scott Hill (Interpretive Ranger)

Background

Thomas Stone National Historic Site (THST) is located in Port Tobacco, Maryland. It was designated as a National Historic Site on November 10, 1978. The total size of the park is 328 acres. THST is the only Network park that does not have a coastline.

The park preserves the history related to Thomas Stone, who was the youngest of Maryland's four signers of the Declaration of Independence. He was a member of the Continental Congress and worked on the Articles of Confederation. THST is the location of his home, Haberdeventure. There was a great fire at the mansion 1977, but it was restored in the 1990s. The main features of the park include the mansion, a trail, and a new visitor center that was just opened on October 5, 2002. The notable natural resources within the park include pockets of rare plant habitats and a variety of bird species.

There is no entrance fee for this park. In 2001, the park received 5,491 recreation visits. Available recreation opportunities include bird watching, hiking, nature walks, wildlife viewing, and attending interpretive programs. Some visitors picnic on the tables near the visitor center. The visitor center shows an introductory video, and a ranger-led tour of the mansion begins every hour. Park staff indicated that most visitors confine their activities in the mansion and other built structures, with few visitors performing natural resource-based activities. In early 2002 the park's walking trail was damaged by a tornado. The trail is being repaired. More outdoor activities are expected while this trail is reopen later. Park staff is interested in exploring low-impact recreation opportunities (such as biking) for visitors.

The park's general management plan was published in March 1990. The document discussed planning issues and management concerns, and it provided recommendations for site development and management. The park's total budget amounted to $589,000 in 2001.

No studies have been conducted in this park with respect to visitor impacts, and there is no visitor use or impact monitoring program established. THST visitors are advised to be careful, as the park is still under development and construction sites can be hazardous.

Visitor Natural Resource Impact Concerns

Through discussion with park staff we identified *no significant impact concern* in this park. This historic site has improved substantially as compared to the pre-park era when serious damage was caused by horseback riding and cattle activities (even inside the mansion). There is no concern about visitor impacts on trails or other facilities due to low amount of use. Trail use has been non-existent after the tornado event.

Park staff voiced concern about a small number of all-terrain vehicles (ATVs) that entered into the park at the western border in order to gain access to state hunting areas. Part of this problem is due to unclear marking of park boundaries.

Initial Monitoring Recommendations

Study Impact Concerns

Based on our observation and discussion with park staff we identified no immediate monitoring needs for this park. However some initial information at this time would be beneficial in assisting the park in establishing a baseline of resource condition. For example, photo monitoring and GPS mapping of the trail locations would be helpful. Therefore the following assessment steps are suggested for the 2003 field season:

1) GPS mapping of all trail locations
2) The development of a series of permanent monitoring photo points along the trails.

A GIS database would be developed with the above information and provided to the NPS at the end of the project in addition to a written report with monitoring protocols and future monitoring suggestions.

Gateway National Recreation Area

Initial Site Visit
October 8, 2002

Project Staff: Christopher Monz and Heather Bauman

Park Staff Present: Kim Tripp, George W. Frame, and Dave Avrin

Background

Gateway National Recreation Area (GNRA) is located in New York metropolitan area and extends through three New York boroughs and into northern New Jersey. The park totals 26,000 acres with over 8 million recreational visits per year.

The NRA is made up of three units: Jamaica Bay, Sandy Hook, and Staten Island. The park has ocean beach habitat that is habitat for many migrating and resident coastal birds including: piping plovers, terns, gulls, and sanderlings. The park also has significant open bay and salt marsh habitats as well as several natural and man made ponds and developing uplands including maritime grasslands, holly forests and a rare swamp-white oak forest.

There are significant developed facilities in the GNRA including a baseball field, tennis courts, campgrounds, fishing, horseback riding, swimming, boating, gardening, historical military sites, cultural festival grounds. In addition to general beach recreation, GNRA provides many organized visitor activities including interpretive events, educational programs at historical sites, poetry readings, opera, symphony, and contemporary musical concerts. Auto touring and ORV use are also popular GNRA activities

Entrance into the park is free, however, fees and permits are required for many of the activities, use of park facilities, camping, lodging, horseback riding, and ORV use.

Gateway has a management plan that was completed in 1979. The park managers acknowledge. The park has altered the management plan by applying Developing Concept Plans (DCP) where needed.

Visitor Natural Resource Impact Issues and Concerns

The park has many dynamic issues largely due to its location within a large metropolitan area. Many different cultural groups live in the surrounding communities and view the use of the park and what it should provide in different ways. Some visitors see the park as a place to conduct religious ceremonies, others see it as a place to harvest food, and many others use it for recreation. Each one of these activities has its own impacts and different assessment and management needs.

The North Channel Bridge

The North Channel Bridge is located in the Jamaica Bay National Wildlife Refuge. This area receives intense use by many people that stop along the side of the bridge to picnic, barbeque and fish. Many problems exist here especially with littering, trampling of native vegetation, and illegal harvesting of clams and fish. There are also illegal fires, the feeding of wildlife (especially seagulls and pigeons), swimming in polluted waters, and trash left over from religious ceremonies. It is clear that this area receives high impact, it is unknown however, what the effects of these impacts are and what management strategies should be taken. The park has, fenced off wildlife sensitive areas, provided fishing line receptacles to this area and information signs about appropriate behavior but managers are unsure on how affective these strategies have been.

Breezy Point

ORV Use

Vehicles are allowed on a half-mile stretch of beach from the sand dunes to the inter-tidal zone, although managers say that there is very little compliance of vehicles staying within these parameters. ORV users are required to pay a fee to obtain a permit. There is currently no limit to the number of vehicles allowed on the beach per day. Managers estimate that they issue 1,000 permits from September through March. Most ORV users drive onto the beach to fish but managers are unsure how many hours they spend on the beach or how often they move to different locations.

Managers are concerned about the use of Off Road Vehicles and its effect upon shorebird habitat. Four-wheel drive vehicles are allowed on the beach after the first of September, when piping plovers, terns, and other migrating and resident birds have finished nesting. Many of the birds continue to use the beach after nesting, however, for feeding and resting. Snowy owls, snow buntings, gulls, and sanderlings and other species also use this area during fall and winter months. Managers have observed vehicles causing shore bird flushing at various times of the year. The closing off date for ORV use was set on March 15th. New regulations set in 2002 allow visitors to drive on the beach until the first piping plover is sighted.

Pedestrian Traffic

Although there is very little fishing from December through March and therefore very little ORV use on the beach, visitors are still allowed to walk along the ocean side as they wish. During the nesting season, pedestrian traffic can be quite high at times and managers are concerned about the disturbance this might have on piping plovers. The park does use posts to mark plover nests, but after the young fledge they need to reach the shoreline to feed and managers are concerned that many of them disturbed significantly by foot traffic. The park prohibits jogging in this area but managers say restrictions such as these are often ignored.

Easier Access

Currently park staff and managers are considering creating more trails and advertising Breezy point to make it more available to visitors.

Bergen Beach
Horseback riding is the main attraction to this area. There are about two miles of managed trails, and a web of social trails off of these. There is concern over the trampling of native vegetation, manure runoff into the bay, and the impact the horses are having on dune stability.

Spring Creek
This site is located on a closed landfill that the park is interested in restoring to a more natural state. There are also many social trails from dirt bikes. There is talk that the Corps of Engineers might help with restoration in this area in another ten to fifteen years. This area currently serves as a buffer to more critical park habitat.

Sandy Hook
This area has an enormous influx of visitors every year. Managers are now discussing the possibility of creating a multi-use paved trail for various types of non-motorized pedestrian traffic running the length of Sandy Hook. Currently, however, demand for this trail is unknown and managers expressed a need to explore the consequences of creating the trail, such as increased access into areas that were previously undisturbed, dealing with illegal campfires, and creating new social trails.

Staten Island
Many visitors come to this area to fish. Managers have observed trampling of the salt marsh vegetation as well as notable social trails.

Skeleton Island/Plum Island
Both of these islands receive substantial visitor use. The main concern in these areas is the illegal harvesting of clams and horseshoe crabs. Currently there is a study being conducted on the poaching.

Plum Beach
This area experiences heavy pedestrian use since it is readily accessible from the parkway. The portable toilets are overrun and improperly disposed human waste has been observed. The salt marsh, dune, and beach areas have extensive social trails. Litter and trash is a concern as well as the poaching of horseshoe crabs.

Initial Monitoring Recommendations
Gateway National Recreation Area provides an extensive array of services to the public. Visitors to the park are diverse in culture, and in their use and view of the park, exacerbating the job of the managers who must balance visitor needs and wants with protection of the parks resources. Although the visitor issues at this park are vast and monitoring needs extensive, we offer the following preliminary suggestions to initiate a limited program of visitor impact monitoring:

Study Impact Concerns

1) Thorough assessment of the location, extent and severity of visitor impacts to the Breezy Point area before access is improved to this location.
2) Thorough mapping and assessment of horse and social trails along Bergen Beach
3) An overall assessment of the amount of trash and litter at several locations, such as the North Channel Bridge area. This can serve as an evaluation of management actions taken to prevent littering.

Colonial National Historic Park, Jamestown and Yorktown, Virginia

Initial Site Visit
December 10-11, 2002

Project Staff: Yu-Fai Leung, Christine Ingle

Park Staff Present: Host--Charles Rafkind (natural resource specialist), Henry Campbell (foreman-Jamestown), Chris Bryce (interpreter-Yorktown), John Short (interpreter-Yorktown), Haram Barber (law enforcement ranger), Lewis Fitzgerald (grounds foreman), Lee Whitlock (trails/parkway foreman), Tom Nash (chief ranger), Jimbo Thompson (law enforcement), Larry Thrower (entrance station), Kurt Gaul (supervisory park ranger)

Background

Established in 1930 as a national monument, Colonial National Historic Park (COLO) is situated on the Virginia peninsula between the cities of Williamsburg and Newport News. The park comprises Jamestown to the south, Yorktown to the north, and a 23-mile parkway connecting these two primary areas. Other detached units of the park include Green Spring and the Cape Henry Memorial. COLO shares part of its boarders with residential neighborhoods. Also adjacent to the park is a US Coast Guard reserve training center and two major US Navy facilities – a supply center and a weapons station. The total acreage of the park is 9,461 acres.

COLO commemorates some of the most significant events in American history. Jamestown was the first permanent English settlement, while Yorktown was the site of the last major battle of the Revolutionary War. In Yorktown visitors can view earthworks, which are built up mounds of earth used in the Revolutionary War and some were used again in the Civil War. The Yorktown National Cemetery in Yorktown holds the remains of soldiers from the Civil War. Green Spring is the plantation home of Virginia's colonial governor, Sir William Berkeley. Finally, the Cape Henry Memorial is situated at the first landing site of the Jamestown colonists.

In addition to rich cultural heritage, COLO possesses a variety of significant natural resources. Wetlands cover 2,200 acres of the park. The York and James Rivers border the park with a total of 30 miles of shoreline with numerous beaches. Twenty-four miles of perennial streams and 30 miles of intermittent streams flow throughout the park, which has a direct hydrological link to the Chesapeake Bay. Three types of forests can be found in the park, including pine, mixed pine, and hardwood. Forested wetlands occur on 730 of those acres. There are 448 species of animals and 1,017 species of vascular flora. Studies by the Virginia Department of Conservation and Recreation, the Division of Natural Heritage, and the park itself indicate that COLO has the second highest amount of rare, threatened and endangered (RTE) species of all NPS units in Virginia. These species include the Bald Eagle, Great Blue Heron, and Great Egret. The Division of Natural Heritage has created a management plan for these species and associated habitats. Studies and inventories have also been conducted, and extensive GIS databases have

been developed on invasive plant species, fish, reptiles and amphibians, macrobenthos, water quality, air quality, and hydrology.

In the early 1980s there were as many as 8.5 million recreational visits to the park, but the level of use declined to about 2 million visits between 1983 and 1993. Since 1994, recreational visits has remained fairly constant around 3 million. In 2001, the park had 3,282,461 recreational visits. Most visitor use occurs between spring and fall, with minimal amount of use occurring in winter. An entrance fee is required for visitors to both Jamestown and Yorktown, or visitors may purchase a combination pass for both sites at a reduced rate. Visitors can participate in the following activities: auto touring, biking, bird watching, fishing, interpretive programs, picnicking, horseback riding, walking, and wildlife viewing. The park's Code of Federal Regulations (COLO-CFR) Compendium has established regulations and restrictions governing visitor use. Most non-traditional activities, such as camping and launching/landing of watercraft, are strictly prohibited. Fishing is restricted in certain areas of the park. Auto touring is allowed on the Colonial Parkway and tour roads. Biking is allowed only on public roadways and is prohibited off road surface. Horseback riding is allowed on road shoulders and cleared fields, with exceptions of Colonial Parkway, the Yorktown National Cemetery and the Jamestown Island south of the entrance gate. Large numbers of visitors typically congregate near Indian Field Creek, College Creek and Cheatham.

The facilities in Jamestown include a visitor center, the Cape Henry Memorial, the reconstructed Glasshouse, and a town site with the excavated ruins of early homes and public businesses. The facilities in Yorktown include a visitor center, the Yorktown Battlefield, the Moore House (site of surrender negotiations), the Yorktown National Cemetery, the Nelson House, and the Poor Potter site. Picnic tables are provided in both visitor centers and along the York River beach (spring-fall only).

Jamestown is jointly administered with the Association for the Preservation of Virginia Antiquities (APVA). The APVA owns 22.5 acres on Jamestown Island. In 2001, the budget for COLO was $5,196,000. Due to budget constraints, the park staff has been reduced. For instance, the maintenance staff has been reduced almost by half. Certain areas of the park have been closed due to lack of funds and staff. The General Management Plan of the park was approved in 1993, while draft development concept plans for Jamestown Island and Green Spring plantation site are going through the public review process.

During our visit the park staff provided a lot of useful information. In addition to the information on the park's website, we obtained a copy of park brochures, the General Management Plan, Draft General Management Plan Amendment/EIS for Green Spring, Draft Development Concept Plan/EIS for Jamestown, and the COLO-CFR. A number of GIS datasets will be acquired from the park. Through literature searches and discussion with park managers *no* studies were identified that investigated visitor impacts on either natural or cultural resources. There is *no* ongoing program developed for monitoring visitor impacts. However, the natural resource specialist indicated that attempt has been made to map the social trails in the park. More details about this effort will be sought.

Visitor Natural Resource Impact Issues and Concerns

Resource Degradation Associated with Off-Road or Mountain Biking
Park staff indicated that resource degradation caused by off-road biking is their *primary* visitor impact concern. While biking is permitted only on the pavement of Colonial Parkway, unofficial biking activities exist in different areas of the park. Such problems are particularly evident in Yorktown near Wormley Pond and the Siege Lane; both are surrounded by residential neighborhood or military facilities. A variety of impacts to natural and cultural resources have resulted. Examples include proliferation of social trails, trampling impacts on groundcover vegetation, soil compaction, soil exposure and erosion along the shoreline and on earthworks, inappropriate disposal of trash, incidents of vandalism of signs, and wildlife disturbance.

Other Illegal Recreation Activities and Associated Impacts
While prohibited recreational use is clearly defined and conveyed to the public through signage and personal communication, illegal recreational use occurs from time to time in the park. The frequency of each type of violation is unknown. Examples that have been observed by park staff include launching of canoes and kayaks, setting up tents on beach, swimming, hunting, and poaching of plants and animals.

Recreational Use Impacts on Colonial Parkway
Recreational use along Colonial Parkway has caused a variety of impacts, though none of the impacts is of critical concern to park managers at the present time. Some of these problems include parking is non-designated places, trampling impacts around overlooks. Most of these visitor impacts are located in high-use overlooks or beaches at College Creek, Mill Creek, Queen's Lake, and Sandy Point. Park management considers trampling impacts on overlooks as one of the forces that accelerates shoreline erosion. Another impact described by park managers is caused by turning around of vehicles on either end of the tunnel traversing underneath Colonial Williamsburg. Another group of concerns is caused by inappropriate or illegal visitor activities along the parkway. Examples include bikers riding abreast (safety and conflict issues), graffiti (Crawford Rd), trash, alcohol use, and drug trafficking. Some recreational use occurs in close proximity to bald eagle's nests. However, observations by park managers suggest that disturbance to the endangered species is not substantial.

Trail Impacts
Degrading conditions of official trails are of concern to park management. We observed an example at the Site of Washington's Headquarters (Yorktown) where a well-used trail tread was actively eroding with gullies developed. This problem may exist on other popular trails in the park. Unofficial or social trails are a related but different problem. As mentioned before, off-road biking is believed to be a major cause of the social trail proliferation within the park. Off-trail walking of visitors, particularly fishermen, further contributes to this problem.

Potential Impacts of New Visitor Facilities
Potential environmental impacts of new visitor facilities and recreational use as proposed in Jamestown and Green Spring draft development concept plans. These proposed facilities include boardwalks and a new visitor center in Jamestown, and a number of trails in wooded areas and open fields in the Green Spring plantation site (the preferred alternative). While most of the potential impacts would be caused by facility development itself rather than visitor activities, increasing recreational use in the two areas is likely to generate impacts to the resource components.

Other Impact Issues
In addition to the above-mentioned issues, COLO park staff has also expressed concern on the following problems:

- The pressure for residential development in the nearby areas that would also result in increased visitor use as well as the difficulty in preventing illegal recreational activities from occurring. Furthermore, surface runoff and groundwater flow generated from residential neighborhood are more likely to cause flooding and bring in a variety of contaminants;
- Dumping of household garbage and construction waste within the park boundaries. This problem has declined in recent years;
- Release of unwanted pets and captured small animals;
- Marine debris along the shoreline a common;
- Impacts due to park management/maintenance activities -- One park scientist indicated that mowing activities by the park staff have caused soil and vegetation damage in the park.

While other impact concerns are legitimate and require research attention, they are beyond the scope of this study as its primary focus in on impacts caused by recreational visitors.

Initial Monitoring Recommendations

Based on our discussion with park staff and preliminary observations, we propose the following monitoring efforts for Colonial NHP, with primary focuses placed on biking-related impacts and visitor impacts at popular use areas or trails:

Study Impact Concerns

1) Mountain biking use and impacts of the park is the primary concern among park staff. Little is known about behavior patterns of mountain bikers. In addition, there is no information or previous studies for quantifying the extent, patterns and trends of resource impacts related to mountain biking despite such a significant concern. We suggest that indicators and monitoring protocols for biking-related impacts be developed and tested in Summer and Fall 2003. Monitoring protocols may include a variety of methodological approaches as discussed earlier in this

report. Some examples are visitor tally, behavior observation and on-site impact assessment. Park staff is expected to be involved in the data collection process in which they document mountain biking activities systematically using a simple form. Information interested includes specific location and direction of movement, time of day, day of week, weather, group size, gender, approximate age, equipment, problem behavior, and other variables. Visitor surveys or interviews could be conducted in the near future if additional resources are provided. Impact assessment should focus on biking-caused social trails and related damage in selected areas within the park. Data gathered may include location, types and intensity of social trail networks, and resource impacts on and along social trails. Geospatial technologies such as GIS and GPS would likely be applied in this kind of assessment. The spatial extent and distribution of impacts can then be estimated. Though the primary focus of this project is the development and testing of candidate indicators and associated monitoring protocols, the data collected in selected areas would serve as the baseline that can be used to compare against future conditions or to evaluate effectiveness of future management actions that address biking impacts. Field impact assessment techniques would be developed and implemented with involvement of park staff.

2) Indicators and monitoring protocols can be developed to assess the current resource condition of existing recreation sites and trails. The study area may include the Colonial Parkway and popular use areas in Jamestown and Yorktown. Site and trail assessment procedures developed in recent studies in Boston Harbor Islands and Cape Cod may be adapted to this park as appropriate. This and the previous tasks would constitute about 2 weeks of field work.

Additional Impact Concerns

3) Visitor damage to cultural resources and impacts caused by maintenance activities may be monitored through some rapid procedures that can be performed by park staff during regular patrols. However, this issue is beyond the scope of this project under the Vital Signs Program.

4) Potential impacts of new visitor facilities have been evaluated in the EIS portion of draft development concept plan documents. Construction and facility development are the major impact source. Due to the logistical and funding constraints this project may not be able to address this issue.

5) Illegal visitor activities, such as garbage dumping, vandalism, hunting/poaching and criminal activities may be evaluated through a compilation and analysis of citations and observation of park staff. These problems occur infrequently and should be incorporated into patrol duties of park staff. They are not considered as a top priority in developing long-term monitoring programs.

Fire Island National Seashore

Initial Site Visit
November 22, 2002

Project Staff: Christopher Monz and Heather Bauman

Park Staff Present: Michael Bilecki, Diane Abell, Steve Singler, Marie Lawrence, Paula Valentine, Libby Schaaf, Paul Czachor, and Jay Lippert

Background

Fire Island is located approximately one hour east of New York City, stretching 32 miles along Long Island's south shore. The island contains some 17 residential communities, a state park, a county park, the national seashore, and the only federal wilderness area in New York State.

Fire Island National Seashore (FINS) occupies 26 miles of the barrier island and contains several ecosystems of note: 1) beach habitat which provides feeding and nesting grounds for the piping plover and many other shorebirds, as well as invertebrates and plant species such as the seabeach amaranth and beach grass; 2) dune habitat which creates a buffer for the rest of Fire Island and Long Island, also supports different species of plants including beach grass, beach heather, and seaside goldenrod; 3) shrub/thicket community containing plant species such as wax myrtle, bay berry, poison ivy, and greenbrier; 4) maritime forests dominated by pitch pines and scrub oak; 5) old growth holly forest; and 6) salt marsh.

FINS most recent general management plan (GMP) was written in 1975. Funding for a new GMP will start in 2004 and Fire Island will receive pre-planning money for Natural and Cultural issues in 2003.

Park staff have conducted vegetation surveys and mapping as well as taken aerial photographs and some GIS mapping. There has not been any Visitor experience and resource Protection Planning (VERP) conducted at Fire Island.

Visitor Natural Resource Impact Issues and Concerns

The majority of visitors come to Fire Island to visit the beach. Parking is located on both sides of the NPS area, at the Robert Moses State Park and Smith Point County Park. Most visitors access the National Seashore from one of these points. Additional visitors access the island's communities by boat or water taxis. The number of visitors that access Fire Island in this way is unclear.

There are 17 communities with 4,000 private homes on Fire Island with approximately four hundred residents living on the island year round. Homeowners that live within the communities of Fire Island often wonder onto the beach and other parkland with friends and family. Many of the houses are also vacation rentals and many of these visitors may be unaware of park regulations. Residents construct houses on the dunes or develop

artificial dunes in front of their house by scrapping the beach, which lowers the elevation of the island. In severe storms houses can be damaged and there will be no dunes to protect the rest of the island. Homeowners have also been known to plant exotic plant species such as bamboo that is very hard to control once it gets established inside the park. Homeowners also need their houses maintained and so the park must allow essential services access to the beach on the ORV free zone.

FINS managers raised the concern that many residences have freshwater pools, birdbaths, and septic systems that are not adequately covered and therefore are perfect breeding grounds for freshwater mosquitoes. The island naturally has plenty of saltwater mosquitoes but very few freshwater. The freshwater mosquitoes carry the West Nile Disease as well as the Eastern Equine Encephalitis (EEE). As a result there has been pressure from the Department of Health to spray pesticides around the island. Managers have not had to spray so far, trying instead to educate and communicate the issue with residents hoping they will take precautions not to leave uncovered water in their yards. The park has also put up two mosquito traps on the island, both close to freshwater sources to monitor for the potential disease vectors.

Water quality is one of the major concerns for park managers. The marinas are areas where pollution from powerboats is potentially a problem. In addition the two-mile boat discharge regulation is not enforced and difficult to enforce. Reports of boaters washing boats in the marina have raised concerns about soap and other materials entering the water. The New York State Department of Environmental Conservation (DEC) has historically performed some water quality testing of a limited scope. The EPA has also tested the ocean and bay side from time to time for human health reasons. Overall managers would like to see some additional water quality tests conducted and water quality monitored on a more frequent basis.

Off-Road Vehicle Use (ORV) is another issue on Fire Island. The ORV zone is located on the beach bordering the Otis Pike Wilderness Area. The only vehicles allowed in the ORV zone are visitors that fish or hunt waterfowl. The park has a good understanding of the numbers of vehicles on the beach, where they will be going, and what they are doing. The concern arises from not knowing how ORVs directly and indirectly affect vegetation, nesting birds, invertebrates, and plant rhizomes. Managers have issued anywhere between 1,000 and 100 permits a day, seeming to depend on the amount of fish in the surf. New regulations are being imposed for vehicles operated by residents, commercial users, and essential services. Managers are planning to move a large part of the driving inland away from the beach. The new regulations will not affect recreational drivers.

Trash is a major issue on Fire Island. Managers have recently implemented a program requiring visitors to pack out any trash that they bring to the island. This policy has had mixed results but overall it seems to work well at most beaches, where there is a noticeable reduction of trash. The marinas are somewhat problematic, as managers must provide the boaters with trashcans while simultaneously encouraging day visitors to pack their trash off the island. In these areas managers have reported more incidences of improperly discarded trash. Trash is typically a problem as many wild animals such as

deer, raccoons, rats and other wildlife feed off of it. At FINS, rats especially have had an historical, noticeable population increase with the increase of trash.

Human interactions with wildlife are frequent at Fire Island. This occurs most often when visitors feed deer. Many of the deer have now become nuisances and are exhibiting attraction behavior.

Trampling of dunes occurs frequently at Fire Island and there are many noticeable social trails extending after the boardwalk trails end. The extent and causes of these trails whether they are from wild deer or visitors needs to be determined.

There are two federally listed species that find habitat at Fire Island. One is the piping plover and the other is the seabeach amaranth. This year managers counted 12 nest sites, the most they have had in many years. Managers are still concerned about the effects of pedestrians, dogs, and ORV use disturbing the birds while nesting or feeding on the island. Sea beach amaranth also occurs on the beach during the summer and spreads its seed in September and October. It is a concern that the ORV zone takes over vital seabeach amaranth habitat. The northeast beach tiger beetle is also on the list of threatened species and it used to occur on Fire Island. The invertebrate has not been seen since the 1920's.

Pets cause some problems on the beach as dogs are allowed on the beach but expected to be on a leash. Managers face many people that allow their dogs to run off the leash and are concerned over the impacts they might be having on the Piping Plover colonies and other wildlife. There are also many feral cats on the island, which of course are harmful to songbirds especially. The impacts of cats and dogs on to wildlife on the island are poorly understood.

Personal watercraft (PWC) use occurs illegally at Fire Island and managers find it almost impossible to enforce the 1,000 ft from the shore boundary limits. Managers are concerned about damage to submerged aquatic vegetation when illegal use occurs close to the shore, but at present it is unclear how frequently these motor crafts come in this close.

Initial Monitoring Recommendations

Study Impact Concerns

1) Assessment and mapping of all the social trails and visitor sites within sensitive areas of FINS, particularly in the Otis Pike Wilderness area. An effort will be made to differentiate between deer trails and human caused trails.
2) Visitor use estimation in sensitive areas via trail counters and direct observation
3) Quantification the level of human disturbance to wildlife by observation with a particular emphasis on piping plover and other shorebird habitat.

4) A preliminary examination of the feasibility of assessing the condition of submerged aquatic vegetation in sensitive areas.

Additional Impact Concerns

5) Water quality testing should be expanded around the marinas and any other critical pollution sites seemingly caused by visitors, as well as some control sites in appropriate areas. This may be most efficiently accomplished by expansion of the established DEC/EPA programs.
6) Trash estimates could also be considered along the beaches, marinas, and other heavily used places to determine the amount of trash left by visitors and how effective the "take in-take out" policy is.

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